

7 Performance Method

7.1 Overview

This chapter explains the performance method of complying with the Standards. The method works by calculating the Time Dependent Valuation (TDV) energy use of the proposed design and comparing it to the TDV energy use of the standard design (the budget). The standard design is a building with the same size as the proposed design, but incorporating all features of Prescriptive Package D. The energy budget includes water heating, space heating, and space cooling. Lighting is not included in the performance calculations. If the proposed design uses equal or less TDV energy than the standard design, then the building complies. This method provides maximum flexibility because the building designer may trade-off the energy performance of different building components and design features to achieve compliance.

Compliance credit is available if the proposed design exceeds the Package D requirements in these areas. There are significant savings opportunities, including:

- Ceiling insulation
- Wall insulation
- Floor insulation
- Slab edge insulation
- Window performance (U-factor and SHGC)
- Operable or Fixed exterior shading devices
- Window orientation
- Thermal mass
- Cool roof
- Radiant barrier
- Air retarding wrap
- Blower door testing
- Proper refrigerant charge in air conditioners
- Heating and cooling equipment efficiency
- High EER air conditioners
- Quality insulation installation
- Maximum cooling capacity
- Supply duct location
- Duct insulation

- Duct sealing, minimized duct surface area, and increased R-value
- Air handler watt draw
- Adequate cooling air flow
- Ice storage air conditioners
- Air conditioners with evaporatively-cooled condensers
- Evaporative coolers
- Roof type
- Insulation above the roof deck
- Mass above the roof deck (> 25 lbs/ft²)
- Passive attic ventilation
- Zonal control
- Water heater efficiency and distribution system type

Credit for many of the above features cannot be taken in the prescriptive packages, but can be taken under the performance approach.

The performance method is the most popular compliance method under the Standards, with more than 95 percent of building permit applications being submitted in this manner. The method is especially popular with production homebuilders because they can optimize performance and achieve compliance at the lowest possible cost.

Computer programs used for compliance are approved by the Energy Commission as being capable of calculating space conditioning and water heating energy use in accordance with a detailed set of rules. The computer programs simulate or model the thermal behavior of buildings by calculating hourly heat flows into and out of the various thermal zones of the building. The tools must demonstrate their accuracy in analyzing annual space conditioning and water heating energy use of different building conservation features, levels and techniques.

Approved computer programs must be able to:

1. Automatically calculate the standard design TDV energy budget for heating, cooling, and water heating.
2. Calculate the TDV energy use of the proposed design in accordance with specific fixed inputs, restricted inputs and user-specified inputs.
3. Print the appropriate standardized compliance reports.

This chapter provides only a general overview of the performance method. Each computer program that is approved by the Energy Commission is required to have a compliance supplement that provides more detailed information regarding the use of the software for compliance purposes. The requirements for the compliance supplement along with other requirements for approved computer programs are documented in the 2008 Residential ACM Manual.

7.2 What's New for 2008

The most significant change in the performance method for low-rise residential buildings for the 2008 Standards is the use of the Unconditioned Zone Model (UZM) to model attic spaces with roofs and ceilings and a new model for slab heat gains and losses. New prescriptive standards for cooling coil air flow and furnace fan Watt draw are also implemented in the Compliance Software allowing tradeoffs. New mandatory requirements for mechanical whole building ventilation along with changes in default envelope leakage have changed the potential performance tradeoffs for tested envelope leakage. Energy impacts of certain ventilation systems installed to meet the new ventilation requirements can also be traded in the performance method. In addition, the 2008 Standards expanded the requirement for insulated kitchen piping to apply to all piping - no matter what the diameter. Adjustments and additions were made to the water heating distribution multipliers for demand recirculation and adjustment factors have been added to low-rise residential buildings for instantaneous gas water heaters and buffer tanks. For multi-family buildings, an adjustment factor has been added for monitored systems or systems with automated time adjusted volume controls.

7.3 The Process

Any approved computer program may be used to comply with the Standards using the performance method. The following steps are a general outline of the typical computer program procedure:

1. Collect all necessary data—areas and thermal characteristics of fenestration products, walls, doors, roofs, ceilings and floors, construction assemblies, including fenestration U-factor and solar heat gain coefficients, equipment efficiencies, water heating information from drawings and specifications. Although most computer programs require the same basic data, some information and the manner in which it is organized may vary according to the particular program used. Refer to the Vendor's Compliance Software User Manual for additional details.
2. Enter data into the computer program describing the surface areas and thermal performance properties of building envelope components, water heating system and equipment, and HVAC system and equipment. Input values and assumptions must correctly correspond to the proposed design and conform to the required mandatory measures.
3. Launch a computer run to automatically calculate the TDV energy of the standard design and the proposed design.

The building complies if the total TDV energy use of the proposed design is the same as or less than the standard design TDV energy budget.

When creating a computer input file, use the space provided for the project title information to concisely and uniquely describe the building being modeled. User-designated names should be clear and internally consistent with other orientations and/or buildings being analyzed. Title names and explanatory comments should assist individuals involved in both the compliance and enforcement process.

7.3.1 Defining the Standard Design

Each approved computer program must automatically calculate the TDV energy use of the standard design. The standard design is created based upon data entered for the proposed design using all the correct fixed and restricted inputs.

The computer program defines the standard design by modifying the geometry of the proposed design and inserting the building features of prescriptive Package D. This process is built into each approved computer program and the user cannot access it. Key details on how the standard design is created and calculated by the computer programs, including the listing of fixed and restricted input assumptions are documented in the 2008 Residential ACM Manual.

The standard design assumes the same total conditioned floor area, conditioned slab floor area, and volume as the proposed design, and the same gross exterior wall area as the proposed design, except that the wall area in each of the four cardinal orientations is equal. The standard design uses the same roof/ceiling area, raised floor area, slab-on-grade area and perimeter as the proposed design, assuming the standard insulation R-values required in the prescriptive packages.

Total fenestration area in the standard design is equal to the proposed design if the fenestration area in the proposed design is less than or equal to 20 percent of the floor area, otherwise, the fenestration area of the standard design is equal to 20 percent of the floor area. Fenestration area in the standard design is evenly distributed between the four cardinal orientations. SHGC and U-factors are those listed in Package D, and no fixed shading devices such as overhangs are assumed for the standard design.

The standard design includes minimum efficiency heating and cooling equipment, as well as the minimum duct R-value with ducts in a vented attic if the proposed design has an attic. Ducts are assumed to be sealed as required by Package D. The standard design also has correct refrigerant charge as required by Package D.

For water heating systems that serve individual dwelling units, the standard design is a gas storage water heater with an Energy Factor (EF) of 0.575. The standard design has a standard distribution system, i.e., the first 5 ft of hot and cold water piping from heating source and the entire length of piping to kitchen fixtures are insulated as specified in §150(j)2A or §150(j)2B.

For water heating systems that serve multiple dwelling units, the standard design system type (central or individual water heaters) is the same as the proposed design system. Other details are provided in the *2008 Residential ACM Manual*.

7.3.2 Standard Reports

For consistency and ease of enforcement, the manner in which building features are reported by Compliance Software programs is standardized. Energy Commission-approved Compliance Software programs must automatically produce compliance reports in this standard format. The principal report is the Certificate of Compliance (CF-1R).

The CF-1R has two highly visible sections, one for special features and modeling assumptions, and a second for features requiring field verification and/or diagnostic testing by approved HERS raters. These two sections serve as a punch list for special consideration during compliance verification by the local

enforcement agency and the HERS rater. Items listed in the Special Features and Modeling Assumptions section indicate that unusual features or assumptions are used for compliance, and they call for special care by the local enforcement agency. Items listed in the HERS Required Verification section are for features that rely on diagnostic testing and independent verification by approved HERS providers/raters to ensure proper field installation. Diagnostic testing and verification by HERS providers/raters is in addition to local enforcement agency inspections.

Table 7-1 lists some of the measures that are to be listed on the CF-1R. For each measure, the table indicates whether building official verification, HERS rater field verification, or HERS rater diagnostic testing is required.

Table 7-1 – Special Features to be Listed on CF-1R

Category	Building Official Verification of Special Features	HERS Rater Verification	HERS Rater Diagnostic Testing	Measure
General	Y			Compliance for all orientations
Ducts			Y	Duct leakage
		Y		Less than 12 ft. of duct outside conditioned space
	Y			100% of ducts in crawlspace/basement
	Y			Supply registers within two ft of floor
		Y		Diagnostic supply duct location, surface area, and R-value
	Y			Ducts in attic with radiant barriers
	Y			Duct increased R-value
		Y		Buried ducts
		Y		Non-standard duct location
Envelope	Y			Air retarding wrap
			Y	Reduced infiltration (blower door). May also require mechanical ventilation.
		Y		Quality insulation installation
	Y			Solar gain targeting (for sunspaces)
	Y			Inter-zone ventilation
	Y			Radiant barrier
	Y			Non-default vent heights
	Y			Vent area greater than 10%
	Y			Exterior shades
	Y			High thermal mass
	Y			Metal framed walls
	Y			Sunspace with interzone surfaces
	Y			Cool roof
HVAC Equip		Y		Charge Indicator Light
			Y	Refrigerant charge
		Y		High EER
	Y			Zonal control
			Y	Air handler fan power
			Y	Adequate air flow
	Y			Hydronic heating systems
		Y		Air conditioner size
Water heating	Y			Combined hydronic
	Y			Non-standard water heaters (wh/unit)
	Y			Water heater distribution credits
	Y			Non-NAECA water heater
	Y			High EF for existing water heaters

A sunspace is a passive solar system consisting of an unconditioned space facing south or near south. See Vendor's Compliance Software User Manual for modeling these spaces.

7.3.3 Professional Judgment

Some modeling techniques and compliance assumptions applied to the proposed design are fixed or restricted. There is little or no freedom to choose input values for compliance modeling purposes. However, other aspects of computer modeling remain for which some professional judgment is necessary. In those instances, exercise proper judgment in evaluating whether a given assumption is appropriate.

The enforcement agencies have full discretion to reject a particular input, especially if the user has not substantiated the value with supporting documentation.

Two questions may be asked in order to resolve whether professional judgment has been applied correctly in any particular case:

1. Is a simplified assumption appropriate for a specific case? If simplification reduces the predicted energy use of the proposed building when compared to a more explicit and detailed modeling assumption, the simplification is not acceptable (i.e., the simplification must reflect higher energy use than a more detailed modeling assumption).
2. Is the approach or assumption used in modeling the proposed design consistent with the approach or assumption used in generating the energy budget?

One must always model the proposed design using the same assumption and/or technique used by the program in calculating the energy budget unless drawings and specifications indicate specific differences that warrant conservation credits or penalties.

Any unusual modeling approach, assumption or input value should be documented with published data and should conform to standard engineering practice.

For assistance in evaluating the appropriateness of particular input assumptions, call the Energy Hotline or call the vendor of the Compliance Software program.

7.4 Mixed Occupancy Buildings

§100(e)

Some residential buildings have areas of other occupancies, such as retail or office, in the same building. An example of this might be a three-story building with two floors of apartments above ground floor shops and offices. The first thing to consider when analyzing the energy compliance of a mixed occupancy building is the type and area of each occupancy type.

Depending on the area of the different occupancies, you may be able to demonstrate energy compliance as if the whole building is residential for the heating cooling and water heating requirements. This is allowed if the residential occupancy accounts for greater than 80 percent of the conditioned floor area of the building (or permitted space). Lighting compliance must be based on the requirements for the actual occupancy type.

Note: Mandatory measures apply separately to each occupancy type regardless of the compliance approach used. For example, if complying under the mixed occupancy exception, both residential documentation (MF-1R form) and nonresidential documentation for mandatory measures must be submitted with other compliance documentation.

If the building design does not fit the criteria described above for a dominant occupancy, then the low-rise residential occupancy type must be shown to comply on its own. The remaining occupancy types must be shown to comply separately either by independent compliance for each occupancy or (for the nonresidential performance approach) by combining nonresidential occupancies in accordance with the rules of the Nonresidential ACM Manual. This may be done by using any of the approved prescriptive or performance methods available for each occupancy type. As a result, documentation for each occupancy type must also be considered separately, and a Certificate of Compliance must be submitted for each occupancy type. Note that mixed high-rise and low-rise residential occupancies will not occur in the same building because the designation applies to the building.

7.5 Multifamily Buildings

§101(b)

Envelope and HVAC equipment requirements for multifamily apartment buildings with four or more habitable stories (and hotels or motels of any number of stories) are covered by the Nonresidential Standards. These are explained in the Nonresidential Compliance Manual. Multifamily buildings with one to three habitable stories are considered low-rise residential buildings and are discussed in this manual.

Compliance for a low-rise multifamily building may be demonstrated either for the building as a whole or on a unit-by-unit basis. Floors and walls between dwelling units are considered to have no heat transfer, and may be ignored in performance calculations.

7.5.1 Whole-building Compliance Approach

The simplest approach to compliance for a multifamily building is to treat the building as a whole, using any of the compliance paths described in earlier chapters. In practice, this process is similar to analyzing a single family dwelling, except for some differences in water-heating budgets and internal gains, as described in the *2008 Residential ACM Manual*.

Multifamily buildings that utilize efficiency measures that require HERS field verification must submit separate compliance documentation for each individual dwelling unit in the building as specified by Reference Residential Appendix Section RA2.3. This requirement does not prevent use of the whole-building compliance approach for submittal of the Certificate of Compliance to the Enforcement Agency, however when the whole-building compliance approach has utilized a measure that requires HERS field verification, a separate copy of the whole-building Certificate of Compliance must be submitted to the HERS provider for every dwelling unit in order to satisfy the requirements of the HERS provider

data registry documentation procedures. In practice, the Certificate of Compliance information may not need to be submitted to the HERS provider more than one time, but a relationship must be established in the HERS provider data registry between the whole-building Certificate of Compliance and the corresponding dwelling-specific Installation Certificates, and the dwelling-specific Certificates of Field Verification and Diagnostic Testing. Thus, for the whole-building compliance approach in a multifamily building that has utilized a compliance option that requires HERS verification, the required energy compliance documentation for each dwelling unit should consist of a whole-building Certificate of Compliance (CF-1R), a dwelling-specific Installation Certificate (CF-6R), and a dwelling-specific Certificate of Field Verification and Diagnostic Testing (CF-4R).

When the whole-building compliance approach is utilized for a multifamily building, some of the energy efficiency measures that require HERS field verification cannot be used for compliance credit in the performance calculations. These HERS measures are excluded from the whole-building compliance approach because they require dwelling-specific data input to the Compliance Software, and dwelling-specific data output from the Compliance Software that must be shown on the Certificate of Compliance, therefore they cannot be properly documented using a single whole-building Certificate of Compliance.

The measures that cannot be utilized for the multifamily whole-building compliance approach are:

- Buried Ducts credit
- Deeply Buried Ducts credit
- Reduced Supply Duct Surface Area credit
- Maximum Rated Total Cooling Capacity credit
- Building Envelope Sealing credit (blower door test)

All other HERS measures are available for use with the multifamily whole-building compliance approach.

When the Standards require registration of the compliance documents, the information for the Certificate of Compliance (CF-1R), Installation Certificate (CF-6R), and Certificate of Field Verification and Diagnostic Testing (CF-4R) must be submitted electronically to the HERS provider data registry. Refer to Reference Residential Appendix RA2 for additional information on these document registration procedures.

7.5.2 Unit-By-Unit Compliance Approach – Fixed Orientation Alternative

The unit-by-unit compliance approach for multifamily buildings requires that each dwelling unit must demonstrate compliance separately. The fixed orientation alternative requires that each unique dwelling unit in the building, as determined by orientation and floor level, must be separately modeled using an approved computer program. In this approach, surfaces that provide separation between dwelling units may be ignored since they are assumed to have no heat loss or heat gain associated with them. Surfaces that provide separation between dwelling units and central/interior corridor areas must be modeled for heat transfer if the corridor area is not directly conditioned (see Reference Joint Appendix JA1

for definition). If the corridor area is conditioned, the corridor area may be modeled separately.

Different orientations and locations of each unit type within the building must be considered separately. That is, a one-bedroom apartment on the ground floor of a three-story building is different from the same plan on a middle floor or the top floor, even if all apartments have the same orientation and are otherwise identical. Likewise, end units must be modeled separately from the middle units; and opposite end units must both be modeled. With this approach every unit of the building must comply with the Standards, so this approach is more stringent than modeling the building as a whole (see Figure 7-1).

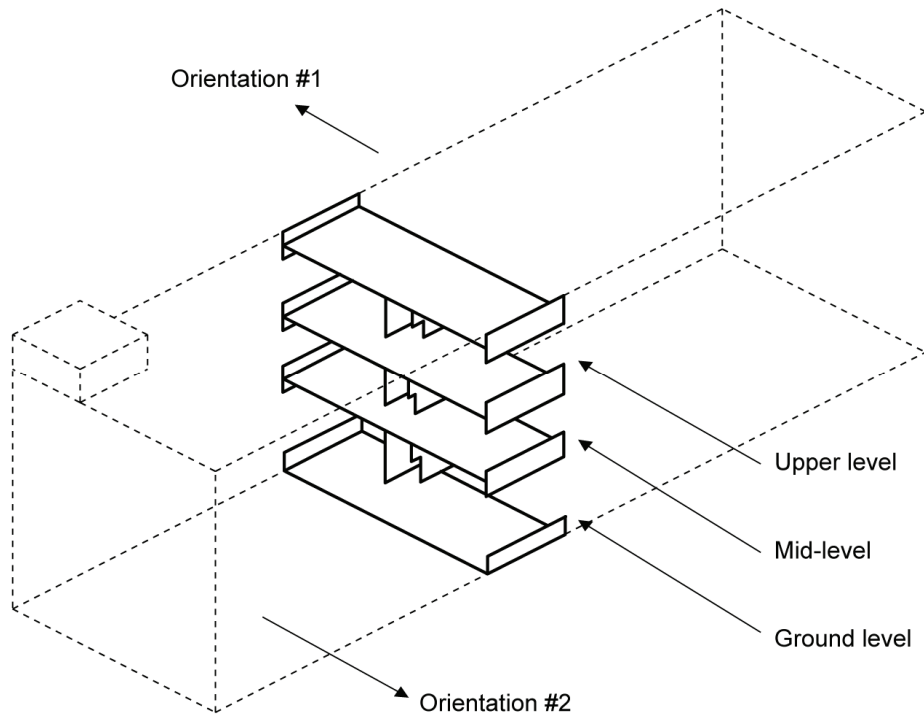


Figure 7-1 – Multifamily Building Compliance Option

Demonstrate Compliance for Each Generic Unit Type in Each of its Characteristic Locations

Example 7-1

Question

When preparing compliance calculations for a three-story apartment complex, I have the option of showing compliance for each dwelling unit or for the entire building. If I use the individual dwelling unit approach, do I need to provide calculations for every dwelling unit?

Answer

Each dwelling unit must comply with the Standards when using this approach. When dwelling units have identical conditions, the calculations can be combined. This means you will show separate compliance for all unique conditions, such as:

- Front-facing North
- Front-facing West

- Front/side walls facing East and North
- Front/side walls facing East and South
- Middle units and both end units
- Exterior roof, no exterior floor
- Exterior floor, no exterior roof

Surfaces separating two conditioned spaces (such as common walls) have little heat transfer and can be disregarded in the compliance calculations.

7.5.3 Unit-By-Unit Compliance Approach – Multiple Orientation Alternative

Another option for showing unit-by-unit compliance for a multifamily building is similar to a method that may be utilized for single family master plans in subdivisions (described in Section 7.6).

The computer method may be used to demonstrate that a dwelling unit plan in a multifamily building complies regardless of how it is oriented. To assure compliance in any orientation, the annual energy consumption must be calculated in each of the four cardinal orientations: true north, true east, true south and true west. With this option, a dwelling unit plan must be modeled using the identical combination of energy features and levels in each orientation, and must comply with the energy budget in each case. If a multifamily dwelling floor plan is utilized as both reversed and original/standard floor plan types, either the reversed plan or the original/standard plan may be used to demonstrate compliance, but compliance must be shown in all four cardinal orientations using only one of the plan types.

Each unique dwelling unit plan must be modeled using the worst-case condition for the energy features that the plan may contain within the multifamily building (e.g. highest glazing percentage, least overhangs, largest wall surface area, and with exterior walls instead of party walls if applicable). See Reference Residential Appendix RA 2.6.1 for information that describes how to determine when a dwelling is considered to be a unique model. Each unique dwelling plan must also be modeled separately for each unique floor level (see Figure 7-1).

7.6 Subdivisions and Master Plans

Subdivisions often require a special approach to energy compliance, since they generally include one or a few basic building or unit plans repeated in a variety of orientations. The basic floor plans, as *drawn*, may also be used in a mirror image or *reversed* configuration.

There are two compliance options for subdivisions. They are:

1. Model each individual building, or building condition, separately according to its actual orientation.
2. Model all four cardinal orientations for each building or plan type with identical conservation features for no orientation restrictions.

7.6.1 Individual Building Approach

The most straightforward compliance option for subdivisions is to analyze each individual building in the project separately using any compliance method. This may be practical for subdivisions with only custom buildings, or with only one or two specific orientations for each building plan. This approach requires that each unit comply separately, with separate documentation submitted for each unit plan in the orientation in which it will be constructed.

7.6.2 Multiple Orientation Alternative: No Orientation Restrictions

§151(c)

The computer method may be used to demonstrate that a single family dwelling plan complies regardless of how it is oriented within the same climate zone. To assure compliance in any orientation, the annual energy consumption must be calculated in each of the four cardinal orientations: true north, true east, true south and true west. With this option, the buildings must have the identical combination of conservation measures and levels in each orientation and comply with the energy budget in each case.

If a building floor plan is reversed, either the original plans or the reversed plans may be shown to comply in all four cardinal orientations.

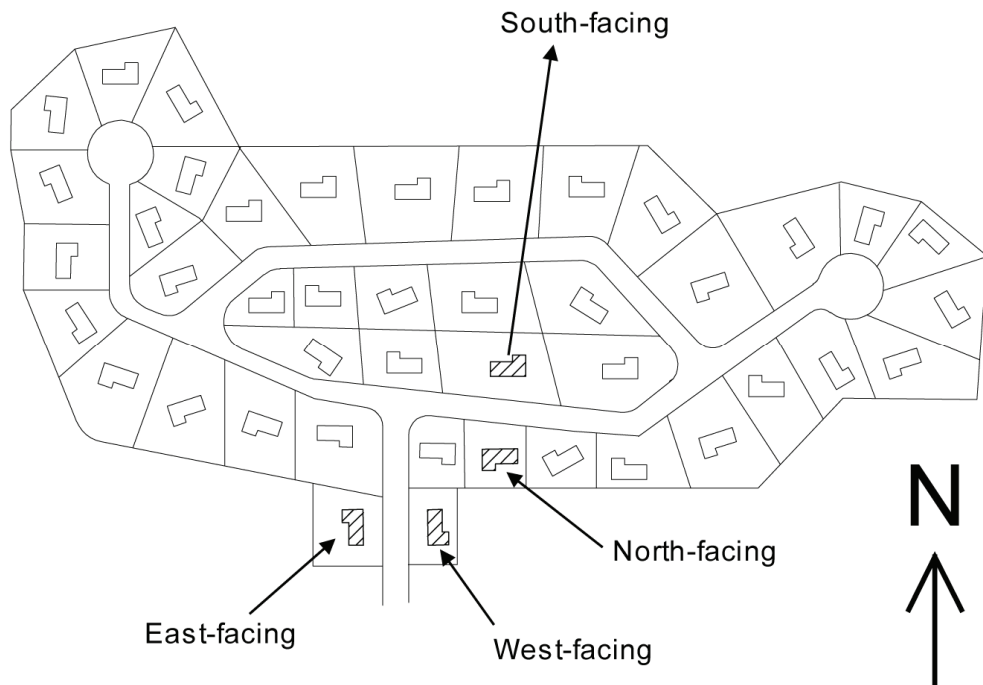


Figure 7-2– Subdivisions and Master Plans Compliance Option

Demonstrate Compliance for Each Cardinal Orientation for Each Basic Model Type

For compliance, submit Certificate of Compliance documentation of the energy budgets for each of the four orientations to the enforcement agency. Only one CF-1R form that documents compliance for all four orientations is required to be submitted to the enforcement agency for each unique plan.

Master plans that utilize the multiple orientation alternative, that utilize a compliance approach that requires HERS field verification, must submit a separate copy of the multiple orientation master plan Certificate of Compliance to the HERS provider for every dwelling unit in the subdivision in order to satisfy the requirements of the HERS provider data registry documentation procedures. In practice, the Certificate of Compliance information for each multiple orientation master plan may not need to be submitted to the HERS provider data registry more than one time, but a relationship must be established in the HERS provider data registry between the applicable multiple orientation master plan Certificate of Compliance and the corresponding dwelling-specific Installation Certificates (CF-6R), and the dwelling-specific Certificates of Field Verification and Diagnostic Testing (CF-4R). Thus, for the multiple orientation compliance approach in a master plan subdivision that has utilized a compliance option that requires HERS verification, the required energy compliance documentation for each dwelling unit should consist of a multiple orientation master plan Certificate of Compliance (CF-1R), a dwelling-specific Installation Certificate (CF-6R), and a dwelling-specific Certificate of Field Verification and Diagnostic Testing (CF-4R).

7.7 HVAC Issues

7.7.1 No Cooling Installed

When a building does not have a proposed cooling system, there is no compliance credit. The air conditioning system is modeled to be equivalent to Package D. A hypothetical cooling duct system is modeled as equivalent to Package D (e.g., Attic, R-6) or as matching the heating system ducts. Modeling no ducts is not an appropriate assumption.

7.7.2 Equipment without SEER or HSPF

For equipment without a tested SEER, the EER is used in place of the SEER. Another option is to use the EER of the equipment and use it for both the SEER and EER entry. If this approach is used, the EER must be verified by a HERS rater.

Equipment without an HSPF rating is assumed to have 3.41 HSPF (electric resistance), 3.55 (electric radiant), or an HSPF calculated from a COP as

$$\text{HSPF} = (3.2 \times \text{COP}) - 2.4.$$

7.7.3 Multiple HVAC Systems

Buildings with multiple HVAC systems not meeting the zonal control criteria (see Section 4.4.2) may model each zone separately without taking credit for zonal control.

For buildings using more than one system type, equipment type or fuel type, where the types do not serve the same floor area, model either the building zone

or enter the floor area served by each type. Note that if both zones are associated with attic space then a portion of the attic must be modeled with each zone.

Floor areas served by more than one heating or cooling system, equipment, or fuel type must simulate the building using the system with the most TDV energy consumption for compliance. For additions with electric resistance heat and another heating system (except for wood heating) the electric resistance shall be deemed to be the most TDV energy consuming system. Supplemental heating units may be installed in a space served directly or indirectly by a primary heating system provided that the thermal capacity of the supplement unit does not exceed two kilowatts or 7,000 Btu/h and is controlled by a time-limiting device not exceeding 30 minutes.

For floor areas served by more than one cooling system, equipment, or fuel type, indicate which system, equipment, and fuel type satisfies the cooling loads.

When there is more than one system meeting the heating or cooling load for the same space, all systems must still meet all the mandatory requirements of the standards.

For example, a building using an appliance rated gas fireplace in combination with a central gas furnace. The central furnace would be used as the primary system and the fireplace would be treated as the supplemental system. The controls for the fireplace would not need to meet the setback thermostat requirements of §112(c) due to the exception.

For rooms such as the bedroom or bathroom, spot heating with a supplemental system may be desirable. An exemption to Tables 151-C, D & E of the Standards is provided for installing either a two kW electric resistance or 7,000 Btu gas heaters, with a 30-minute timer control for such instances. Therefore, this type of supplemental space heating need not meet the setback thermostat requirement.

7.7.4 Gas-Fired Cooling Systems

Gas-fired (absorption) cooling systems are modeled three descriptors, COP95, the rated COP for the gas portion, CAP95, the rated capacity, and PPC, the parasitic electric energy at rated conditions in Watts.

See Vendor's Compliance Software User Manual for details on how to model these types of systems.

7.7.5 Existing + Addition + Alteration Approach

The performance approach may be used to show compliance for alterations in existing buildings, new additions, and Existing + Addition + Alteration. This topic is discussed in Chapter 8, Section 8.7.3 Existing + Addition + Alteration Approach of this manual.